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HYDROPHOBIA

POPULAR alarm has of late been aroused by the publication of an unusual number of cases of death from this most terrible disease, and interest and hope have been excited by the statement that, at last, a drug has been found—curare—which does exert such an influence that at least one case is said to have been rescued from otherwise certain death. We propose to discuss briefly in this article the chief points in the natural history of hydrophobia, to examine what light, if any, science has thrown upon its nature, and to inquire what reasons there are for believing in the alleged efficacy of drugs in its treatment.

Hydrophobia is a disease which never occurs spontaneously in man, being invariably communicated to him by the bite of some animal affected with it—commonly by the dog, more rarely the cat, more rarely still the fox and wolf. The bite induces the disease by permitting the absorption of the saliva of the diseased animal, the peculiar poison or "*materies morbi*" of the disease being contained in the saliva. Inasmuch, then, as man only becomes affected with hydrophobia through the intermediation of the lower animals, it will be necessary to consider it, first of all, as it makes itself manifest in them.

It has been, and still is, a subject of dispute amongst veterinarians whether hydrophobia, or "rabies," was originated spontaneously in the dog. Avowedly the immense majority of cases of the disease can be proved to have been due to the bites of rabid animals; some cases do occur, however, in which it is stated that there was no possibility of contact with a diseased animal, and these are held to prove the occasional spontaneous origin of the disease. Now, whilst we are not prepared absolutely to contradict such a surmise, and to allege that at no time, and under no circumstances, hydrophobia originated spontaneously, we do hold that there is no better evidence of such a new origin *now* than there is of the spontaneous generation of the poisons which induce small-pox, scarlet fever, or measles. In the case of these diseases, as in that of hydrophobia, it does sometimes happen that some of the links in the chain of evidence are lost which are required to prove the connection between one case of disease and its precursor, but the exceptional cases do not outweigh the immense mass of evidence which proves that each of the diseases previously mentioned is as certainly the offspring of a previous case as is each animal or plant at present living the offspring of a pre-existing parent organism. We shall then probably be quite right in assuming that not only is it true of hydrophobia as it affects man, but of the disease as it is manifest in all animals, that it is always due to the inoculation of poison from a diseased into a healthy organism.

In commencing a description of hydrophobia we must point out that whilst the disease is always more or less prevalent, periods when it becomes much more frequent occur from time to time. Within the present century, especially between 1800 and 1830, several such outbreaks occurred; in this respect hydrophobia resembles other diseases of the zymotic class, which, though always more or less prevalent, only occasionally prevail with epidemic intensity. We must assume that at this period the circumstances which are required for the spread of the particular disease are specially favourable, though it is only rarely that we can do more than surmise what these special circumstances really are.

In the dog, as indeed in all animals, there is a period of latency, or as it is technically termed, of "incubation," which intervenes between the inoculation of the poison of hydrophobia and the development of any symptoms; this period varies remarkably: it may be as short as a week, or as long as three months; the greater number of cases occurring, however, between the twentieth and fiftieth days after the poisonous wound has been inflicted. It must not be supposed that the bite of a rabid dog always induces the disease in other dogs which it bites; a certain number of such bites prove abortive. Thus, out of 131 dogs which had been bitten by, or inoculated with, the virulent saliva of certainly rabid dogs, only sixty-three fell victims. The failures in these cases are to be explained in several ways. In some cases it is probable that the saliva was not active, just as sometimes the liquid from the vaccine vesicle, when fairly tested, is found to be incapable of reproducing vaccinia; in other cases the poisonous saliva has doubtless been prevented from penetrating the wound, having been retained by the hair and cuticle of the bitten animal; finally, in a third class of cases, it must be assumed that the bitten animal did not offer conditions required for the development of the disease. A case is, indeed, recorded, on the best authority, in which a pointer dog was caused to be bitten on seventeen separate occasions by dogs affected with rabies, without the disease being induced.

The period of incubation having passed, the first symptoms of rabies usually consist in a change in the temper of the dog, which becomes sullen and snappish, and which often bites those around it, even without any provocation. This prominence of the cerebral symptoms in the early stages of hydrophobia in the dog is very remarkable, and contrasts, as will be seen in the sequel, with the phenomena of the disease in man. It is evidenced not merely by the tendency to bite, but by the whole changed aspect of the animal, which is now observed to be obviously ailing. The appetite becomes capricious, food often being refused, and all kinds of rubbish swallowed, and often, though by no means invariably, the dog utters dismal howls. It is in this stage that the dog often wanders from home, and apparently under the influence of maniacal excitement, rushes on, biting all dogs which it meets, and often all human beings who happen to come in its way. It is to be noted that the dog does not exhibit any of the dread of water which is so painfully evident in the disease as it affects man; this depends upon the fact that in the dog there appears to be little, if any, tendency to spasm of the muscles of deglutition. As the disease advances palsy of the posterior extremities often occurs; in other cases a peculiar paralysis of the muscles connected with the lower jaw sets in, so that the suffering animal is unable to utter any sound, and is said to be suffering from "dumb-madness." Throughout the disease there is usually an increased secretion of viscid saliva. The whole course of hydrophobia in the dog is run in from four to eight days, the majority of cases proving fatal about the fourth or fifth day. This short description of rabies or hydrophobia, as it affects the dog, is almost exactly applicable to the disease as it occurs in other domestic animals; a maniacal excitement and a tendency to injure men and animals with which they come in contact being as characteristic of herbivorous animals as it is of dogs, cats, foxes, and wolves.

Having, then, before us an outline of hydrophobia as it affects the lower animals, let us compare with it the disease as it is observed in man.

In the first place as to the frequency with which the bite of a mad dog is followed by hydrophobia. No general satement can be made on this matter, as the results vary very greatly according to the part bitten, according to the treatment to which the bitten part is subjected, &c. For instance, bites inflicted upon parts protected by clothing are followed by hydrophobia much less frequently than those in which the hand or face is injured, the poison in the former case being absorbed by the intervening clothing.

Next, as to the period of incubation. In man this varies even more than in the case of the dog; the majority of cases of human hydrophobia have, however, a period of incubation which varies between thirty and fifty days, though exceptional cases occur in which many months have elapsed between the infliction of the bite and the supervention of the symptoms; these remarks might be illustrated by reference to cases which have occurred in England, and which have been recorded in the medical journals during the last two years; the shortest period of incubation observed within this period having been eighteen days, and the longest nine months. During the period of incubation there is nothing to distinguish a bite inflicted by a rabid dog from the bite of a healthy dog. The study of some of the recorded cases of the disease would almost lead to the conclusion that in man there is during the period of incubation a tendency to nervous depression and melancholia which is a precursor of the terrible symptoms which are to follow; it is obvious, however, that great caution ought to be exercised in the interpretation of such mental symptoms, which are after all in many cases but the necessary and logical results of an injury of which the possible consequences are but too well known and correspondingly dreaded. If we except these symptoms of depression and melancholy there are no characteristic phenomena which intervene between the infliction of the bite and the onset of the attack of hydrophobia.

In a certain number of cases the advent of the disease is ushered in by pain of a neuralgic character in the bitten part; this appears to be merely an evidence of the general feeling of illness which then supervenes, rather than any evidence of the specific nature of the bite. More commonly the first phenomena are merely vague symptoms of feeling very unwell, accompanied often by an intense feeling of melancholy. A deep sighing character of the inspirations, or even paroxysmal attacks of difficulties of breathing, with some pain in the throat and pain in the præcordial region often follow. Beyond the feeling of impending evil, there is no mental symptom at this stage of the disease at all comparable with those observed in the lower animals. Next in the order of accession is the difficulty which the poor patient experiences in swallowing; this, at first slight, symptom soon acquires a terrible intensity; the patient is troubled by an agonising thirst, and yet dares not drink; any attempt to drink gives rise to a terrible spasm of the muscles engaged in deglutition, and apparently to a simultaneous spasm of the muscles engaged in inspiration so powerful that he dreads suffocation. An analysis of the symptoms at this stage leads one, indeed, to the opinion that swallowing is often dreaded because of, and is indeed impeded by, the spasm of the inspiratory muscles which it induces. Then follows a stage in which often, though by no means invariably, the patient becomes subject to delusions, and often violently maniacal, and this is succeeded by a stage of exhaustion and quiet which ushers in the fatal termination.

If we have sketched with some degree of minuteness the outlines of a very painful picture, we have done so because a knowledge of them was absolutely essential before we could attempt to consider what light science has thrown upon this dread disease, and what reliance is to be placed upon the remedies which have been suggested for its cure.

We shall now, in the first place, consider the results of pathological investigations relating to hydrophobia. Are there not some well marked and constantly present lesions of the great nerve-centres corresponding in some measure to the symptoms which manifest themselves during life? The older observations generally concur in showing that the brain and spinal cord are the seat of congestions which are, however, not sufficiently constant in their localisation to admit of any conclusions being drawn from them. And, since the time when pathological anatomy attained its present development and accuracy, but few persons sufficiently competent to draw accurate conclusions from their observations have had the opportunity of working at the subject. From the observations of Benedict (*Virchow's Archiv*, 1875), it resulted, that in addition to more or less widely spread congestion, there occur granular degeneration of nerve-cells, and of nerve-fibres in various parts of the brain. Subsequently Wassilieff, working under the direction of Prof. Botkin, of St. Petersburg, described (*Centralblatt f. d. med. Wissenschaft*, 1876, p. 625) *a*, some alterations in the nerve-cells of the medulla oblongata, the outlines and nuclei of which are indistinct and the contents cloudy; *b*, a large accumulation of corpuscles of the size of white blood-cells in the interstitial connective tissue of the brain, in the peri-vascular canals and immediately surrounding them; and *c*, the presence of a highly refracting substance in the peri-vascular spaces, especially in the cortical layers of the cerebral hemispheres. Somewhat akin to them are the observations of Dr. Gowers who found in the medulla oblongata after death from hydrophobia, accumulations of cells, resembling white blood-cells, in the vicinity of the blood-vessels, and also in the nervous substance. But what do all these observations indicate? In all probability the accumulations of white cells are caused by the emigration of white blood corpuscles from the blood, so that they are to be held as supporting the older observations which alleged congestions of the brain to be frequently present, and the other pathological changes noticed by the three observers to whom we have referred, cannot as yet be adequately interpreted.

Pathological anatomy then helps us a little in our attempts to elucidate hydrophobia. Can we obtain better results by reasoning upon the symptoms and course of the disease from the standpoint of physiology? Hardly, but we may make the attempt. Physiology necessarily cannot help us to understand the nature of the peculiarly subtle poison which can lurk so long in the system without betraying its presence by any symptom, but she may help us in explaining the phenomena which it induces. Of this poison we know as little, if not less, than of the other poisons which are capable of inducing zymotic diseases. Each of those diseases appears to depend upon a definite *materies morbi*, upon the presence of which the peculiar phenomena of each depend; but the periods which elapse between the introduction of the poison and the manifestation of the disease varies in each case, no less than the course and duration of the disease, and the organs and tissues of the body which are affected. Thus, in scarlet fever the poison induces changes in the epitheliated surfaces of the body, manifested by the rash, the sore throat, the acute kidney affection; in typhoid fever anatomical changes of the most obvious nature are wrought in the alimentary canal, and lead to the special dangers of the disease; in typhus, again, the poison, whilst producing changes in the general nutrition of the body, and exciting a specially-marked action upon the brain proper (as evidenced by the marked affection of all mental processes), produces no typical anatomical changes. These diseases all illustrate the fact that the poison of each zymotic disease affects certain tissues and organs of the body, and it might be easily shown that it is by the implication of particular functions that each of these poisons *usually* induces death. Is there, in the case of hydrophobia, any evidence that it affects specially any particular organ of the body? Yes; a physiological analysis of the disease reveals the fact that its symptoms depend upon an affection of the nerve-centres, and especially of the medulla oblongata.

These essential symptoms are—the spasmodic difficulty of breathing, which depends upon a spasm of the *inspiratory* mechanism and a spasmodic affection of the group of muscles engaged in deglutition. The nerve-centres which preside over respiration and the co-ordinated movements of deglutition are situated in the medulla oblongata, and it is these centres which appear to be peculiarly affected. The reflex excitability of this portion of the nervous apparatus becomes first of all heightened so that a stimulus applied to the mucous membrane of the gullet, which in health would give rise to a normal contraction of the muscles of deglutition, travelling on to the morbidly irritable medulla, throws the centre presiding over deglutition into a state of tonic spasm so intense as to be acutely painful; not confining its action to this one centre, the stimulus is able to throw the contiguous respiratory centre into a similar state of spasm, and the patient runs the risk of suffocation because the movements of the thoracic box, which are essential causes of the passage of air into and out of the lungs, cease for a time. The mechanism of suffocation in these cases resembles that observed when the upper end of the pneumogastric nerve is stimulated by a succession of strong induction shocks, except that in hydrophobia the abnormal effect is doubtless due not to the intensity of the stimulus, but rather to the heightened excitability of the nerve-centres implicated. Apparently a subtle animal-poison acting upon an intensely vulnerable but limited part of the nervous mechanism induces in it an action similar in kind to that produced by strychnia upon the spinal cord. Under the influence of this well-known poison the excitability of the nerve-centres in the cord is heightened, so that a stimulus reaching it by an afferent nerve which would in the healthy unpoisoned condition lead to the reflex and painless contraction of but a small group of muscles, will be able to throw the nerve-cells of the whole cord into intense activity, and as a result occasion the characteristic and terribly painful convulsions of strychnia poisoning. There are, indeed, other facts besides those previously mentioned which point to a state of irritation and increased nervous excitability of the medulla and contiguous nerve-centres. Thus it has been observed that occasionally the pulse has been abnormally slow, a result almost certainly due in these cases to an excitation of the inhibitory centre in the medulla—of that centre which exerts a moderating or restraining influence upon the heart's action; further, it not unfrequently happens that towards the close of the hydrophobic stage, stimuli which were at first only capable of inducing the spasms of deglutition and inspiration, are able to bring on attacks of general convulsions. Here we have a still further extension of the effects of the irritation due to an extension of the reflex excitability from the medulla to the spinal cord.

Our analysis of the symptoms of hydrophobia reveals that as a rule the spasmodic stage terminates before death, which is not produced, as in strychnia poisoning, by the mechanical result of the convulsions—suffocation—but apparently by a more general, though we confess unknown, action of the poison on the organism generally. We know as little of the mode of death in this case as we do in that of scarlet fever, or diphtheria, or typhus, each one of which *may* produce death without leading to the anatomical results which, at any rate in the case of the two former of these diseases are their usual accompaniments. Zymotic poisons may indeed leave as few traces of their action as the simpler and better known poisons such as prussic acid or morphia, so that whilst we cannot disregard the local manifestations or changes which they induce, and which of themselves are a frequent source of danger, we must admit that they are in many cases—nay in most cases—secondary in importance to the more general phenomena which are the expression of the poisonous influence affecting the organism.

(*To be continued.*)

ANCIENT HISTORY FROM THE MONUMENTS

Ancient History from the Monuments. The History of Babylonia. By the late George Smith; edited by A. H. Sayce. *The Greek Cities and Islands of Asia Minor.* By W. S. W. Vaux. (Society for Promoting Christian Knowledge, 1877.)

THE Society for Promoting Christian Knowledge has been doing a very useful work in acquainting the public with the historical results of recent Oriental research